What is claimed is:

1. A multistage adaptive partial parallel interference canceller (PIC) in a downlink receiver having a plurality of channels, for removing multiple access interference (MAI) and interpath interference (IPI), comprising:

a filter matched to a desired walsh code and a scrambling code for despreading and integrating output signals of a rake receiver;

a soft limiter for performing soft decisions and generating a soft-limited signal;

a weighting control means cascaded to the soft limiter for controlling a slope of the soft limiter;

a re-spreading means for respreading the soft-limited signal outputted from the soft limiter based on a walsh code and a scrambling code, and generating a re-spread signal;

an interference generator for computing MAI and IPI included in the signal received at the rake receiver; and

an interference signal removing means for removing the MAI and IPI from a signal received at the rake receiver.

2. The apparatus as recited in claim 1, wherein the interference canceller of each stage includes:

a normalizing means for normalizing the signal outputted from the rake receiver by using a sum of squared path gains of each finger of the rake receiver.

3. The apparatus as recited in claim 2, wherein the soft limiter performs the soft decisions based upon equation expressed as:

$$\tanh(\omega U) = \frac{e^{\omega U} - e^{\omega U}}{e^{\omega U} + e^{\omega U}} \quad ,$$

wherein ω denotes the slope at the origin of the function and U represents an input signal.

4. The apparatus as recited in claim 3, wherein the weighting control means controls the slope ω based on LMS algorithm.

5. The apparatus as recited in claim 3, wherein the weighting control means controls the slope ω based on average to variance ratio estimation algorithm.

6. The apparatus as recited in claim 1, wherein the interference generating means computes the interference signals based upon equation expressed as:

$$\begin{aligned}
&\text{For } i = 1 \text{ to } N \text{ and } j = 1 \text{ to } 4 \\
&z_i(t) = \sum_{j=1}^{4} z_{ij}(t) \\
&IPI_{ai}(t) = \overline{b}_i(t - lT_c)\, z_i(t - lT_c) + \overline{c}_i(t - mT_c)\, z_i(t - mT_c) \\
&IPI_{bi}(t) = \overline{a}_i(t + lT_c)\, z_i(t + lT_c) + \overline{c}_i(t - (m-l)T_c)\, z_i(t - (m-l)T_c) \\
&IPI_{ci}(t) = \overline{a}_i(t + mT_c)\, z_i(t + mT_c) + \overline{b}_i(t + (m-l)T_c)\, z_i(t + (m-l)T_c)
\end{aligned}$$

wherein a(t), b(t) and c(t) are path gains of each finger of the rake receiver, z(t) is the respread signal, $1/T_c$ is a chip rate, and lT_c and mT_c are the propagation delays of the 2nd and 3rd paths.

7. The apparatus as recited in claim 6, wherein the interference generating means computes a compensation signal based upon equation expressed as:

$$\begin{aligned}
IPS'_{ij}(t) = {} & \Pi\left(\frac{t - {(R_j+l)T_c}/{2}}{(R_j-l)T_c}\right)\bar{a}_i(t)\bar{b}_i(t-lT_c)z_{ij}(t-lT_c) \\
& +\Pi\left(\frac{t - {(R_j+m)T_c}/{2}}{(R_j-m)T_c}\right)\bar{a}_i(t)\bar{c}_i(t-mT_c)z_{ij}(t-mT_c) \\
& +\Pi\left(\frac{t - {(R_j-l)T_c}/{2}}{(R_j-l)T_c}\right)\bar{b}_i(t)\bar{a}_i(t+lT_c)z_{ij}(t+lT_c) \\
& +\Pi\left(\frac{t - {(R_j+(m-l))T_c}/{2}}{(R_j-(m-l))T_c}\right)\bar{b}_i(t)\bar{c}_i(t-(m-l)T_c)z_{ij}(t-(m-l)T_c) \\
& +\Pi\left(\frac{t - {(R_j-m)T_c}/{2}}{(R_j-m)T_c}\right)\bar{c}_i(t)\bar{a}_i(t+mT_c)z_{ij}(t+mT_c) \\
& +\Pi\left(\frac{t - {(R_j-(m-l))T_c}/{2}}{(R_j-(m-l))T_c}\right)\bar{c}_i(t)\bar{b}_i(t+(m-l)T_c)z_{ij}(t+(m-l)T_c),
\end{aligned}$$

$$IPS_{ij}(t) = IPS'_{ij}(t)/B_i(t) \text{ where } B_i(t) = \bar{a}_i^2(t) + \bar{b}_i^2(t) + \bar{c}_i^2(t)$$

wherein R_j is a spreading gain and the interference

canceller of each stage further includes:

a signal compensation means for adding the compensation signal with an interference-removed signal.

8. The apparatus as recited in claim 1, further including:

a deinterleaver/decoder for correcting an error of a signal; and

an interleaver/encoder for interleaving and encoding.

9. A multistage adaptive partial parallel interference canceller (PIC) in a downlink receiver having a plurality of channels, for removing multiple access interference (MAI) and interpath interference (IPI), comprising:

a filter matched to a desired walsh code and a scrambling code for despreading and integrating output signal of a rake receiver;

a soft limiter for performing ~~a~~ soft decisions and generating a soft-limited signal;

a weighting control means cascaded to the soft limiter for controlling a slope of the soft limiter;

a re-spreading means for respreading the soft-limited signal outputted from the soft limiter based on a walsh code and a scrambling code, and generating a re-spread signal;

an interference generator for computing MAI and IPI included in the output signal of the rake receiver; and

an interference signal removing means for removing the MAI and IPI from the output signal of the rake receiver.

10. The apparatus as recited in claim 9, wherein the interference canceller of each stage includes:

a normalizing means for normalizing the signal outputted from the rake receiver by using a sum of squared path gains of each finger of the rake receiver.

11. The apparatus as recited in claim 10, wherein the soft limiter performs the soft decision based upon equation expressed as:

$$\tanh(\omega U) = \frac{e^{\omega U} - e^{\omega U}}{e^{\omega U} + e^{\omega U}} \quad ,$$

wherein ω denotes the slope at the origin of the function and U represents an input signal.

12. The apparatus as recited in claim 11, wherein the weighting control means controls the slope ω based on LMS algorithm.

13. The apparatus as recited in claim 11, wherein the weighting control means controls the slope ω based on average to variance ratio estimation algorithm.

14. The apparatus as recited in claim 9, wherein the

interference generating means computes the interference signals based upon equation expressed as:

$$\text{For } i=1\sim N \text{ and } j=1\sim 4$$

$$z_i(t)=\sum_{j=1}^{4} z_{ij}(t)$$

$$\begin{aligned}IPI'_i(t)=&\overline{a}_i(t)(\overline{b}_i(t-lT_c)z_i(t-lT_c)+\overline{c}_i(t-mT_c)z_i(t-mT_c))+\\&\overline{b}_i(t)(\overline{a}_i(t+lT_c)z_i(t+lT_c)+\overline{c}_i(t-(m-l)T_c)z_i(t-(m-l)T_c))+\\&\overline{c}_i(t)(\overline{a}_i(t+mT_c)z_i(t+mT_c)+\overline{b}_i(t+(m-l)T_c)z_i(t+(m-l)T_c))\end{aligned}$$

$$B_i(t)=\overline{a}_i^2(t)+\overline{b}_i^2(t)+\overline{c}_i^2(t)$$

$$IPI_i(t)=IPI'_i(t)/B_i(t)\quad,$$

wherein a(t), b(t) and c(t) are gains of each of the rake receiver, z(t) is the respread signal, $1/T_c$ is a chip rate, and lT_c and mT_c are the propagation delays of the 2nd and 3rd paths.

15. The apparatus as recited in claim 14, wherein the interference generating means computes a compensation signal IPS' based upon equation expressed as:

$$\begin{aligned}IPS'_{ij}(t)=&\Pi\left(\frac{t-\frac{(R_j+l)T_c}{2}}{(R_j-l)T_c}\right)\overline{a}_i(t)\overline{b}_i(t-lT_c)z_{ij}(t-lT_c)\\&+\Pi\left(\frac{t-\frac{(R_j+m)T_c}{2}}{(R_j-m)T_c}\right)\overline{a}_i(t)\overline{c}_i(t-mT_c)z_{ij}(t-mT_c)\end{aligned}$$

$$+\Pi\left(\frac{t-{(R_j-l)T_c}/{2}}{(R_j-l)T_c}\right)\overline{b}_i(t)\overline{a}_i(t+lT_c)z_{ij}(t+lT_c)$$

$$+\Pi\left(\frac{t-{(R_j+(m-l))T_c}/{2}}{(R_j-(m-l))T_c}\right)\overline{b}_i(t)\overline{c}_i(t-(m-l)T_c)z_{ij}(t-(m-l)T_c)$$

$$+\Pi\left(\frac{t-{(R_j-m)T_c}/{2}}{(R_j-m)T_c}\right)\overline{c}_i(t)\overline{a}_i(t+mT_c)z_{ij}(t+mT_c)$$

$$+\Pi\left(\frac{t-{(R_j-(m-l))T_c}/{2}}{(R_j-(m-l))T_c}\right)\overline{c}_i(t)\overline{b}_i(t+(m-l)T_c)z_{ij}(t+(m-l)T_c),$$

$$IPS_{ij}(t)=IPS'_{ij}(t)/B_i(t) \text{ where } B_i(t)=\overline{a}_i^2(t)+\overline{b}_i^2(t)+\overline{c}_i^2(t)$$

wherein R_j is a spreading gain and the interference canceller of each stage further includes:

a signal compensation means for adding the compensation signal with an interference-removed signal.

16. The apparatus as recited in claim 9, further including:

a deinterleaver/decoder for correcting an error of a signal; and

an interleaver/encoder for interleaving and encoding.

17. A multistage adaptive partial parallel interference canceller (PIC) in an uplink receiver having a plurality of channels, for removing multiple access

interference (MAI) and interpath interference (IPI), comprising:

a filter matched to the desired walsh code and scrambling code for despreading and integrating an output signal of the rake receiver;

a soft limiter for performing ~~a~~ soft decisions and generating a soft-limited signal;

a weighting control means cascaded to the soft limiter for controlling a slope of the soft limiter;

a re-spreading means for respreading the soft-limited signal outputted from the soft limiter based on a walsh code and a scrambling code, and generating a re-spread signal;

an interference generator for computing MAI and IPI included in the signal received at the output of rake receiver; and

an interference signal removing means for removing the MAI and IPI from a signal received at the rake receiver.

18. The apparatus as recited in claim 17, wherein the interference canceller of each stage includes:

a normalizing means for normalizing the signal outputted from the rake receiver by using a sum of squared path gains of each finger of the rake receiver.

19. The apparatus as recited in claim 18, wherein the soft limiter performs the soft decision based upon equation

expressed as:

$$\tanh(\omega U) = \frac{e^{\omega U} - e^{\omega U}}{e^{\omega U} + e^{\omega U}} \quad ,$$

wherein ω denotes the slope at the origin of the function and U represents an input signal.

20. The apparatus as recited in claim 19, wherein the weighting control means controls the slope ω based on LMS algorithm.

21. The apparatus as recited in claim 19, wherein the weighting control means controls the slope ω based on average to variance ratio estimation algorithm.

22. The apparatus as recited in claim 17, wherein the interference generating means computes the interference signals based upon equation expressed as:

$$\text{For } j = 1 \text{ to } 4 \ \ and\ i = 1 \text{ to } N$$

$$z_{oij}(t) = \left(\overline{a}_{ij}(t) z_{ij}(t) + \overline{b}_{ij}(t - lT_c) z_{ij}(t - lT_c) + \overline{c}_{ij}(t - mT_c) z_{ij}(t - mT_c)\right)$$

$$MAI_{oij}(t) = \sum_{\substack{l=1 \\ l \neq j}}^{4} z_{oil}(t)$$

$$MAI_{ij}(t) = \left(\overline{a}_{ij}(t) MAI_{oij}(t) + \overline{b}_{ij}(t) MAI_{oij}(t + lT_c) + \overline{c}_{ij}(t) MAI_{oij}(t + mT_c)\right)$$

$$IPI_{ij}(t) = \Pi\left(\frac{t - \frac{l}{2}T_c}{3T_c}\right) \overline{a}_{ij}(t) \overline{b}_{ij}(t - lT_c) z_{ij}(t - lT_c) + \Pi\left(\frac{t - \frac{m}{2}T_c}{mT_c}\right) \overline{a}_{ij}(t) \overline{c}_{ij}(t - mT_c) z_{ij}(t - mT_c)$$

$$+\Pi\left(\frac{t-\left(R_j-\frac{l}{2}\right)T_c}{lT_c}\right)\bar{b}_{ij}(t)\bar{a}_{ij}(t+lT_c)z_{ij}(t+lT_c)+\Pi\left(\frac{t-\frac{(m-l)}{2}T_c}{(m-l)T_c}\right)\bar{b}_{ij}(t)\bar{c}_{ij}(t-(m-l)T_c)z_{ij}(t-(m-l)T_c)$$

$$+\left(\frac{t-\left(R_j-\frac{m}{2}\right)T_c}{mT_c}\right)\bar{c}_{ij}(t)\bar{a}_{ij}(t+mT_c)z_{ij}(t+mT_c)+\Pi\left(\frac{t-\left(R_j-\frac{(m-l)}{2}\right)T_c}{(m-l)T_c}\right)\bar{c}_{ij}(t)\bar{b}_{ij}(t+(m-l)T_c)z_{ij}(t+(m-l)T_c)$$

$$I_{ij}(t)=\left(MAI_{ij}(t)+IPI_{ij}(t)\right)/B_{ij}(t),\quad \text{where } B_{ij}(t)=\bar{a}_{ij}^2(t)+\bar{b}_{ij}^2(t)+\bar{c}_{ij}^2(t)\quad ,$$

wherein a(t), b(t) and c(t) are path gains of each finger of the rake receiver, z(t) is the respread signal, $1/T_c$ is a chip rate, and lT_c and mT_c are the propagation delays of the 2nd and 3rd paths.

23. The apparatus as recited in claim 22, further including:

a deinterleaver/decoder for correcting an error of a signal; and

an interleaver/encoder for interleaving and encoding.

24. A multistage adaptive partial parallel interference canceller (PIC) in an uplink receiver having a plurality of channels, for removing multiple access interference (MAI) and interpath interference (IPI), comprising:

a soft limiter for performing ~~a~~ soft decisions and generating a soft-limited signal;

a weighting control means cascaded to the soft limiter for controlling the slope of the soft limiter;

a re-spreading means for respreading the soft-limited

signal outputted from the soft limiter based on a walsh code and a scrambling code, and generating a re-spread signal;

an interference generator for computing MAI and IPI included in the output signal of the matched filter;

a filter matched to a desired walsh code and a scrambling code for despreading and integrating the output signals of a rake receiver; and

an interference signal removing means for removing the MAI and IPI from an output signal of the filter.

25. The apparatus as recited in claim 24, wherein the interference canceller of each stage includes:

a normalizing means for normalizing the signal outputted from the rake receiver by using a sum of squared path gains of each finger of the rake receiver.

26. The apparatus as recited in claim 25, wherein the soft limiter performs the soft decision based upon equation expressed as:

$$\tanh(\omega U) = \frac{e^{\omega U} - e^{\omega U}}{e^{\omega U} + e^{\omega U}} \quad ,$$

wherein ω denotes the slope at the origin of the function and U represents an input signal.

27. The apparatus as recited in claim 26, wherein the

weighting control means controls the slope ω based on LMS algorithm.

28. The apparatus as recited in claim 26, wherein the weighting control means controls the slope ω based on average to variance ratio estimation algorithm.

29. The apparatus as recited in claim 24, wherein the interference generating means computes the interference signals based upon equation expressed as:

$$\text{For } j = 1 \text{ to } 4 \ \ and \ \ i = 1 \text{ to } N$$

$$z_{oij}(t) = \left(\bar{a}_{ij}(t) z_{ij}(t) + \bar{b}_{ij}(t - lT_c) z_{ij}(t - lT_c) + \bar{c}_{ij}(t - mT_c) z_{ij}(t - mT_c)\right)$$

$$MAI_{oij}(t) = \sum_{\substack{l=1 \\ l \neq j}}^{4} z_{oil}(t)$$

$$MAI_{ij}(t) = \left(\bar{a}_{ij}(t) MAI_{oij}(t) + \bar{b}_{ij}(t) MAI_{oij}(t + lT_c) + \bar{c}_{ij}(t) MAI_{olj}(t + mT_c)\right)$$

$$\begin{aligned} IPI_{ij}(t) = {} & \Pi\left(\frac{t - \frac{l}{2}T_c}{lT_c}{}_c\right) \bar{a}_{ij}(t) \bar{b}_{ij}(t - lT_c) z_{ij}(t - lT_c) + \Pi\left(\frac{t - \frac{m}{2}T_c}{mT_c}\right) \bar{a}_{ij}(t) \bar{c}_{ij}(t - mT_c) z_{ij}(t - mT_c) \\ & + \Pi\left(\frac{t - \left(R_j - \frac{l}{2}\right)T_c}{lT_c}\right) \bar{b}_{ij}(t) \bar{a}_{ij}(t + lT_c) z_{ij}(t + lT_c) + \Pi\left(\frac{t - (m-l)\frac{(m-l)}{2}T_c}{2T_c}\right) \bar{b}_{ij}(t) \bar{c}_{ij}(t - (m-l)T_c) z_{ij}(t - (m-l)T_c) \\ & + \left(\frac{t - \left(R_j - \frac{m}{2}\right)T_c}{mT_c}\right) \bar{c}_{ij}(t) \bar{a}_{ij}(t + mT_c) z_{ij}(t + mT_c) + \Pi\left(\frac{t - \left(R_j - \frac{(m-l)}{2}\right)T_c}{(m-l)T_c}\right) \bar{c}_{ij}(t) \bar{b}_{ij}(t + (m-l)T_c) z_{ij}(t + (m-l)T_c) \end{aligned}$$

$$I_{ij}(t) = \left(MAI_{ij}(t) + IPI_{ij}(t)\right) / B_{ij}(t), \quad \text{where } B_{ij}(t) = \bar{a}_{ij}^2(t) + \bar{b}_{ij}^2(t) + \bar{c}_{ij}^2(t)$$

wherein a(t), b(t) and c(t) are gains of each of the rake receiver, z(t) is the respread signal, $1/T_c$ is a chip rate, and ~~1~~ lT_c and mT_c are the propagation delays of the

2nd and 3rd paths.

30. The apparatus as recited in claim 22, further including:

a deinterleaver/decoder for correcting an error of a signal; and

an interleaver/encoder for interleaving and encoding.